William Cravens

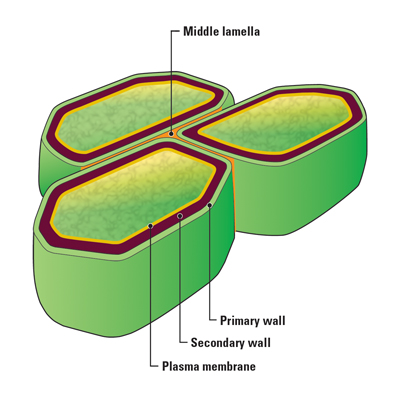
Cell walls are found in [plants](http://en.wikipedia.org/wiki/Plant), [bacteria](http://en.wikipedia.org/wiki/Bacteria), [fungi](http://en.wikipedia.org/wiki/Fungus), [algae](http://en.wikipedia.org/wiki/Alga), [archaea](http://en.wikipedia.org/wiki/Archaea). [Animals](http://en.wikipedia.org/wiki/Animal) and [protozoa](http://en.wikipedia.org/wiki/Protozoa) do not have cell walls. The plant cell wall is a matrix of cellulose microfibrils cross-linked by hemicellulose, pectin, and extension. Plant cells grow by localized loosening of the cell walls and expansion of the vacuole resulting from osmotic influx of water. The acid-growth hypothesis states that cell-wall expansion is caused by an acid-dependent activation of the cell-wall protein expansin, which loosens hydrogen-bonded cellulose microfibrils.

**Structure of Plant Cell Walls**

**Strata or Layers**

**The Middle Lamella**

The [middle lamella](http://en.wikipedia.org/wiki/Lamella_%28cell_biology%29), a layer rich in [pectins](http://en.wikipedia.org/wiki/Pectin). This outermost layer forming the interface between adjacent plant cells and glues them together.



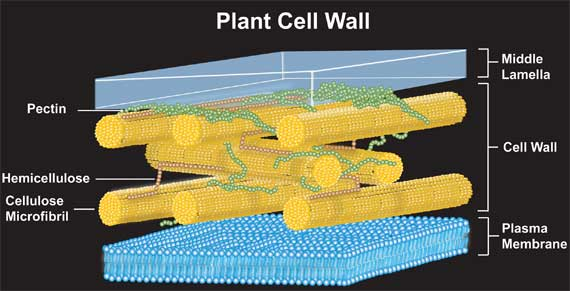
**Primary Cell Wall**

The primary cell wall, generally a thin, flexible and extensible layer formed while the cell is growing.

1.**[carbohydrate](http://en.wikipedia.org/wiki/Carbohydrate" \o "Carbohydrate)s**

* [**cellulose**](http://en.wikipedia.org/wiki/Cellulose)- a [polysaccharide](http://en.wikipedia.org/wiki/Polysaccharide), crystalline, strong, and resistant to [hydrolysis](http://en.wikipedia.org/wiki/Hydrolysis)
* [**hemicellulose**](http://en.wikipedia.org/wiki/Hemicellulose)-has a random, amorphous structure with little strength, hey bind with [pectin](http://en.wikipedia.org/wiki/Pectin) to cellulose to form a network of cross-linked fibres.

Ex.[xyloglucan](http://en.wikipedia.org/wiki/Xyloglucan" \o "Xyloglucan).

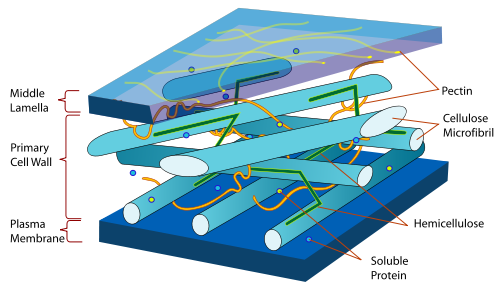
* pectin-structural [heteropolysaccharide](http://en.wikipedia.org/wiki/Heteropolysaccharide), is used in food as a [gelling agent](http://en.wikipedia.org/wiki/Gelling_agent) particularly in [jams](http://en.wikipedia.org/wiki/Jam) and jellies. n the middle lamella between plant cells, pectin helps to bind cells together and regulates water in the plant.
* outer part of the primary cell wall of the plant epidermis is usually impregnated with [cutin](http://en.wikipedia.org/wiki/Cutin) and [wax](http://en.wikipedia.org/wiki/Wax), forming a permeability barrier known as the [plant cuticle](http://en.wikipedia.org/wiki/Plant_cuticle).hydroxy-[fatty acids](http://en.wikipedia.org/wiki/Fatty_acid) and [wax](http://en.wikipedia.org/wiki/Wax), forming a permeability barrier known as the [plant cuticle](http://en.wikipedia.org/wiki/Plant_cuticle).
* 

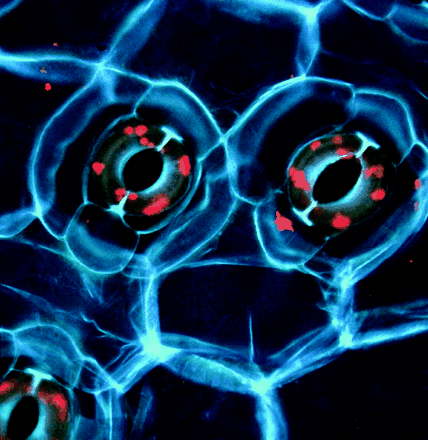
**Secondary**

There are a wide range of additional compounds that modify the mechanical properties and permeability of plant cell walls. The [secondary cell wall](http://en.wikipedia.org/wiki/Secondary_cell_wall), a thick layer formed inside the primary cell wall after the cell is fully grown. It is not found in all cell types. In some cells, such as found [xylem](http://en.wikipedia.org/wiki/Xylem), the secondary wall contains [lignin](http://en.wikipedia.org/wiki/Lignin), which strengthens and waterpoofs the wall.

Example:

[polymers](http://en.wikipedia.org/wiki/Polymer) that make up [wood](http://en.wikipedia.org/wiki/Wood) (largely secondary cell walls) include cellulose (35 to 50%), [xylan](http://en.wikipedia.org/wiki/Xylan), a type of hemicellulose, (20 to 35%) and a complex phenolic polymer called [lignin](http://en.wikipedia.org/wiki/Lignin) (10 to 25%). Lignin penetrates the spaces in the cell wall between cellulose, hemicellulose and pectin components, driving out water and strengthening the wall.





Pair of stomatal guard cells in the leaf epidermis of the plant Commelina communis viewed under UV light. Cell walls emit blue fluorescence due to phenolic compounds. Red fluorescence is emitted by chlorophyll. The guard cell wall polysaccharide arabinan plays an essential role in stomatal closing, which is important for gas and water exchange.

Algae cell Walls

Algae are the plants with the simplest organization. Many of them are single-celled and some types of algae don’t even have a cell wall. In some way algae are good for tracing back the evolution of the cell wall. No clear difference between primary and secondary cell wall exists in most algae. The walls of the [Chlorophyta](http://www.answers.com/topic/chlorophyta) (green algae) show characteristics virtually identical to those of flowering plants, an indication that flowering plants are derived evolutionarily from this division of [algae](http://www.answers.com/topic/alga" \t "_top). Primitive cell walls do not fulfill the same requirements as that of higher plant. The middle layer contains an extensive grid-shaped framework of polygonal plates consisting mainly of glycoproteins, while the layers above and below display fibre-like structures. The thickness of the outer layer varies since it includes components that the cell takes up from its surroundings.

**Strucural Components**

* Cellulose
* **Mannanes-** the main structural elements, the cause of the partially crystalline organization of microfibrils
* **Xylanes-** Breakdown of specific compounds in algae cell walls

 [Alginic acid](http://en.wikipedia.org/wiki/Alginic_acid) - a common polysaccharide in the cell walls of [brown algae](http://en.wikipedia.org/wiki/Brown_algae)

* **Calcium-** Calcite is produced in the walls of some groups of red algae and in charophycea

Function

The Cell wall mediates between the cell and its surroundings. It protects not only the cell but serves, too, communication with cells of the same or other types. It has to be permeable for metabolites and regulators and / or to carry receptor molecules with which it may contact other cells.

The main structural elements of all plant cells are polysaccharides. Differences in their chemical composition cause fundamentally different physical properties. No plant cell wall consists only of one class of molecules. The interactions of the different molecules produce properties that allow to distinguish the cell walls of certain classes.

The wall gives cells rigidity and strength. In multicellular organisms, it permits the organism to build and hold its shape.Limits the entry of large molecules that may be toxic to the cell preventing [osmotic lysis](http://en.wikipedia.org/wiki/Osmotic_lysis)(a cell bursts due to an [osmotic imbalance](http://en.wikipedia.org/wiki/Osmosis) that has caused excess water The wall serves as the first point of entry of materials into cells, functions in the movement of water throughout the plant, and is one of the major mechanical strengthening factors. In addition, the wall must be sufficiently flexible and plastic to [withstand](http://www.answers.com/topic/withstand) mechanical stresses while still permitting the growth of the cell.to move into the cell. It occurs in a [hypotonic](http://en.wikipedia.org/w/index.php?title=Tonihyucity&action=edit&redlink=1) environment, where water [diffuses](http://en.wikipedia.org/wiki/Diffusion) into the cell and causes its volume to increase. If the volume of water exceeds the [cell membrane](http://en.wikipedia.org/wiki/Cell_membrane)'s capacity then the cell will burst. and helping to retain water.The cell wall is flexible, but has considerable tensile strength, apparent in plant wilting(The apparent rigidity of primary plant tissues is a function of hydraulic [turgor pressure](http://en.wikipedia.org/wiki/Turgor_pressure) of the cells and not due to rigid cell walls.)The primary cell wall of most [plant cells](http://en.wikipedia.org/wiki/Plant_cell) is [semi-permeable](http://en.wikipedia.org/wiki/Semipermeable_membrane) and permit the passage of small molecules and small proteins, [water](http://en.wikipedia.org/wiki/Water) and [carbon dioxide](http://en.wikipedia.org/wiki/Carbon_dioxide).

* Structural and mechanical support.
* maintain and determine cell shape.
* resist internal turgor pressure of cell.
* control rate and direction of growth.
* ultimately responsible for plant architecture and form.
* regulate diffusion of material through the apoplast.
* carbohydrate storage - walls of seeds may be metabolized.
* protect against pathogens, dehydration, and other environmental factors.
* source of biologically active signalling molecules.
* cell-cell interactions.

Research Done with (Biofuel, biodiesel, biomass)

Biomass refers to plant matter grown to generate [electricity](http://en.wikipedia.org/wiki/Electricity) or produce [biofuel](http://en.wikipedia.org/wiki/Biofuel), but it also includes plant or animal matter used for production of fibers, [chemicals](http://en.wikipedia.org/wiki/Chemical) or heat. Secondary walls may help to reduce our dependence on petroleum, as they account for the bulk of renewable biomass that can be converted to fuel. Plant cell walls contain long chains of sugars (polysaccharides) that can be converted to transportation fuels such as ethanol, through fermentation of these sugars. Significant challenges for efficient conversion are presented by both the large number of enzymes required to hydrolyze diverse sugar linkages and the physical inaccessibility of these compounds to enzymes because other cell-wall components are present. Some properties of lignin, however, interfere with enzymatic conversion of polysaccharide components. Additionally, since lignin is not readily converted to ethanol, we must find other ways it can be used if we are to maximize the yield of energy from biomass.

**Genomics of cellulosic biofuels**

*Nature* **454**, 841-845 (14 August 2008) | doi:10.1038/nature07190

Edward M. Rubin

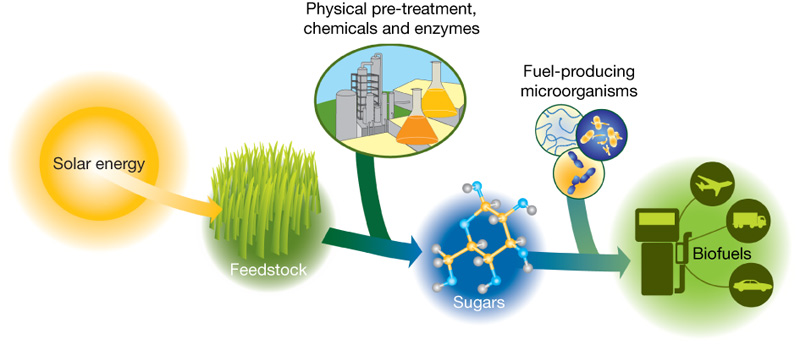
US Department of Energy's Office of Science, Biological and Environmental Research Program

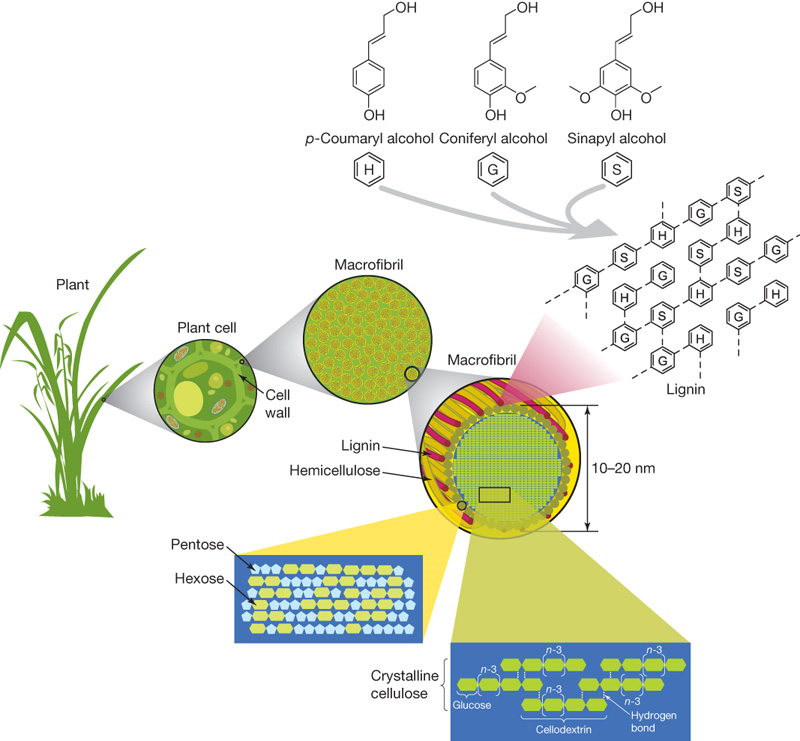
University of California

Los Alamos National Laboratory

Genomic information gathered from across the biosphere, including potential energy crops and microorganisms able to break down biomass, will be vital for improving the prospects of significant cellulosic biofuel production.

Lignocellulosic biomass in the form of plant materials (for example, grasses, wood and crop residues) offers the possibility of a renewable, geographically distributed and relatively greenhouse-gas-favourable source of sugars that can be converted to ethanol and other liquid fuels. Calculations of the productivity of lignocellulosic feedstocks, in part based on their ability to grow on marginal agricultural land, indicates that they can probably have a large impact on transportation needs without significantly compromising the land needed for food crop production[2](http://www.nature.com.foyer.swmed.edu/nature/journal/v454/n7206/full/nature07190.html#B2). biodiesel, derived from oil-producing plants and microbes. Oil-producing algae are also under active study as an alternative source for biodiesel production. One of the major advantages of algae is their growth in liquid, negating the issue of potential competition between food and energy crops for land use.



 we are now prospectively defining criteria to choose plants with potential to serve as dedicated bioenergy crops in the future. These include cell wall composition, growth rate, suitability for growth in different geographical regions, and resource-use efficiencies. With these features in mind, a list of potential bioenergy crops is being developed and targeted for different growing conditions. Plants using C4 photosynthesis tend to be among the most productive, having higher maximum efficiencies of light, nitrogen and water use in assimilating carbon. The C4 group of potential energy crops includes various perennial grasses such as switchgrass and *Miscanthus*. These grasses have the advantages of not requiring replanting after a yearly harvest, rapid growth, high biomass density per unit area, and low nutrient and water needs, enabling growth on marginal agricultural land. unable to grow at temperatures below 10 °C. In these environments, trees, which exclusively depend on C3 photosynthesis, provide the only candidate species. The C3 group of potential energy crops includes trees, such as poplar and eucalyptus, which have relatively rapid growth potential in difficult-to-plough environments. It is highly likely that multiple different energy feedstocks will be deployed depending on latitude, geography, water availability and landowner acceptance.

<http://www.answers.com/topic/cell-wall>

<http://www.biologie.uni-hamburg.de/b-online/e26/26d.htm>

<http://www.gmo-compass.org/eng/database/enzymes/96.xylanase.html>

<http://www.ccrc.uga.edu/~mao/intro/ouline.htm>

<http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=mcb.section.6590>

<http://www.pnas.org/content/100/20.cover-expansion>

<http://genomicsgtl.energy.gov/biofuels/placemat2.shtml>

<http://www.jgi.doe.gov/News/news_8_13_08.html>